

Project Plan  
For  
Reconstruction Work in Central America

Regional Program

Phase I  
October 1, 1999 - September 30, 2000  
and  
Phase II  
October 1, 2000 - December 31, 2001

August 2000

U.S. Department of Commerce  
National Oceanic and Atmospheric Administration  
U.S. National Weather Service

## Table of Contents

I. INTRODUCTION	1
A. Background	1
B. Purpose of the Project Plan	1
II. STATEMENT OF PROBLEMS AND ISSUES	3
III. PROJECT OBJECTIVES	4
A. NWS Activities	4
B. Coordination of Activities	9
C. Applicability to Other Plans	11
IV. MANAGEMENT PLAN	12
A. NWS Management Structure and Responsibilities	12
B. NWS Contact Information	13
C. USAID Mission Assistance	13
D. Measures of Progress	14
E. Program Sustainability	14
F. Equipment Turnover	14
V. SCHEDULE AND BUDGET	15
A. Schedule	15
B. Budget	17

### I. INTRODUCTION

This Project Plan focuses on activities to be accomplished by the Department of Commerce, National Oceanic and Atmospheric Administration, U.S. National Weather Service (hereafter, NWS) for the period through December 31, 2001. This plan supersedes the Phase I Project Plan dated November 1999 since the activities described in that plan have been updated based on further evaluations and meetings with counterpart agencies.

#### A. Background

Hurricane Mitch was one of the most powerful and destructive hurricanes to affect Central America. The late October 1998 storm impacted most of the Central America countries, with most damages and losses due to flooding and mudslides from the torrential rains that fell throughout the region. At its peak on October 26 and 27, the hurricane had sustained winds of 180 miles per hour and triggered four consecutive days of torrential rains. Hurricane Mitch was

the strongest October Atlantic hurricane on record.

The devastation was unprecedented. More than 50% of the infrastructure was destroyed on Honduras and Nicaragua, over 11,000 people were killed and 2,000,000 left homeless. The event set back economic development in the four most affected countries by more than a decade.

In addition to the destruction to the economic and social infrastructure by Hurricane Mitch, important portions of the hydrometeorological monitoring network, equipment instrumental in the monitoring and forecasting of these types of events, were also damaged or destroyed. Even before the hurricane, deficiencies in infrastructure and management provided little capacity to anticipate and respond to extreme climatic events.

#### B. Purpose of the Project Plan

The purpose of this plan is to document the activities to be performed by the Department of Commerce, National Oceanic and Atmospheric Administration, U.S. National Weather Service (hereafter, NWS) under the Interagency Agreement (IAA) signed on September 14, 1999. The IAA is between the Department of Commerce (DoC) and the U.S. Agency for International Development (USAID) defining reconstruction work in Central America (Hurricane Mitch) and the Caribbean (Hurricane Georges). The IAA incorporates in full the U.S. Department of Commerce's *Implementation Plan for Reconstruction Work in Central America*, July 1999 as well as the IAA Addendum to support the Regional -Guatemala Central America Program (USAID/G-CAP) program for Improved Regional Capacity to Mitigate Transnational Effects of Disasters.

This Project Plan will address the activities proposed in the DoC Plan and will discuss the problems and issues, objectives, management approach, coordination of activities and applications to other project plans for the reconstruction program.

The focus of the NWS Project Plan is support to the regional USAID/G-CAP program for the transnational watershed. However, several other, smaller NWS regional activities are also discussed. The NWS regional program supports the specific country activities involving the reconstruction and expansion of hydrometeorological monitoring networks (where appropriate) and the development of early warning systems for weather-related natural disasters (focusing on floods) through provision of technology, technical support and capacity building (training). This Project Plan does not discuss activities to the detail of a work plan but provides specifics as to implementation approaches and presents an overall schedule.

### III. STATEMENT OF PROBLEMS AND ISSUES

In addressing the poorly developed and maintained infrastructure, poor watershed management, inappropriate locations of population, and limited capacity to anticipate and respond to extreme natural events, various programs and activities are being carried out at the country level by the countries themselves (through various donors) and by different U.S. Government agencies. These national programs however, are not sufficient to totally resolve Central America's vulnerability problems.

Due to the relatively small size of the Central American countries (seven countries comprise an area  $\frac{3}{4}$  the size of Texas), there are a relatively large number of shared international boundaries, watersheds, and cross-border impacts. Accordingly, regional initiatives are needed to

complement these national-level activities to ensure reduction in vulnerability to natural disasters. These initiatives can apply to various management activities and programs, all designed to improve capabilities and make these activities and programs more efficient.

The need for regional approaches to problems is most evident in dealing with disasters but is also seen in the routine management of natural resources. People and institutions in different countries work independently often making unilateral decisions that affect other countries. This is most evident with transnational watersheds. Often upstream actions by one country have detrimental downstream consequences on another. The vulnerability of infrastructure (e.g., power plants and bridges), population centers, and agriculture in a downstream country may be increased by poor management practices in a neighboring upstream country. Even poor watershed management practices (or lack thereof), including coordination of various public agencies, can severely affect a country. Therefore, there is a strong need for an improved framework for integrated watershed management, especially for transnational watersheds, that coordinates efforts in different countries and different sectors toward a common set of watershed management objectives.

USAID/G-CAP, in cooperation with Central America regional organizations, will address this need by implementing a program for sound management and disaster mitigation in the Río Lempa watershed. This watershed is shared by Guatemala, Honduras, and El Salvador. This pilot program will then be the model for other, similar programs throughout the Central America isthmus.

The NWS program supports these regional management issues. The NWS program directly supports the USAID/G-CAP Special Objective Document (SpO), *Improved Regional Capacity to Mitigate Transnational Effects of Disasters* and applies directly Intermediate Result Number 1 - Framework Established for Sound Transnational Watershed Management. The program is also consistent with the USAID/Bi-lateral Central America Missions SpOs, which focus on reducing this vulnerability in each country.

## V. PROJECT OBJECTIVES

Consistent with the DoC *Implementation Plan for Reconstruction Work in Central America* and the IAA Addendum addressing the Regional Watershed Management Program, the NWS will address the following defined problem areas in the region - 1) Disaster Preparedness and Response and 2) Regional Watershed Management. The Disaster Preparedness and Response activities are for the entire Central America region while the Regional Watershed Management activities focus on the development of sound management practices in the Río Lempa watershed. The NWS program will provide technology, technical support and capacity building (training). The NWS activities will be designed in coordination with activities defined by other U.S. Government organizations including the DOC and USGS (see Chapter III, Section B).

### A. NWS Activities

The NWS Phase I activities are identified in Table 1. These activities are to be completed by September 30, 2000. The NWS Phase II activities are identified in Table 2. These activities will be completed by December 31, 2001. The level of effort for each activity in Phase II (e.g., number of precipitation gages installed) is contingent on actual costs to implement and unforeseen problems.

An important aspect in the development of this plan is the identification of the appropriate Central America country and regional counterpart agencies to which this technology will be transferred. The NWS will work with the regional agencies to define the requirements for the NWS and Regional Watershed Management programs and to develop approaches to implement

the activities. It is assumed that the Central America regional agencies, along with USAID/G-CAP, will work with the NWS in defining the appropriate country counterpart agencies that will be given the responsibility for operations and maintenance of the technology, and accordingly, become part of the technology implementation through cooperative development programs. Coordination will occur with the following Central America regional agencies.

- **SG-SICA** - the *General Secretariat - Central America System for Integration* (the umbrella secretariat for the following institutions)
- **CCAD** - the *Central America Commission for Environment and Development*
- **CRRH** - the *Regional Committee on Hydrologic Resources*
- **CEPRENAC** - the *Regional Center for the Prevention of Natural Disasters in Central America*

NWS contractors will perform many of the implementation tasks. The NWS, with its contractors, will provide complete installation and check out of all hardware and software. Counterpart country agency resource commitments will be extensive for the Río Lempa program activities. Support will be needed during program implementation to obtain and analyze data and during cooperative development/training activities including training provided during installation and implementation. Some training may be required in the United States. Responsible counterpart agencies will also need to provide resources for operation and maintenance of installed systems and for telecommunications requirements.

**Table 1. NWS Activities for Phase I (through September 30, 2000) - Regional**

Problem Area	Activities	Description	Location
Disaster Preparedness and Response (Central America Regional Program)	Develop a framework for a regional center in support of hydrometeorological activities in Central America	Strengthen Forecasting, Warning, Preparedness, and Response Institutions (Training and Capacity Building)	
	1) Work with CRRH to develop a concept of a framework for a regional center to manage hydrometeorological applications and issues such as sustainability issues for hydro-meteorological hardware and software used for monitoring and for early warning	2) Workshop on flood forecasting with the NWSRFS for meteorological and hydrological counterpart agencies from all affected countries	CRRH (NOAA to provide resources)
			United States
Regional Watershed Management (Río Lempa Program)	Implement a Hydrologic Forecast System for the Río Lempa Watershed	1) Design and begin implementation of the National Weather Service River Forecast System for the Río Lempa watershed (see Appendix for implementation description, workshops)	El Salvador

<b>Table 2. NWS Activities for Phase II (October 1, 2000 - December 31, 2001) - Regional</b>			
<b>Problem Area</b>	<b>Activities</b>	<b>Description</b>	<b>Location</b>
Disaster Preparedness and Response (Central America Regional Program)	Develop a framework for a regional center in support of hydrometeorological activities in Central America	Strengthen Forecasting, Warning, Preparedness, and Response Institutions (Training and Capacity Building)	1) Complete a framework for a regional center to support hydrometeorological activities in Central America
2) Workshop on hydrologic forecasting for meteorological/hydrological counterpart agencies from all affected countries (NOAA/World Meteorological Organization sponsored)	3) Support a regional workshop on maintenance procedures, planning and regionalization approaches	4) Workshop series on forecast center operations presented by NWS	CRRH (NOAA to provide resources)
United States	El Salvador or Guatemala, or Honduras	El Salvador, Guatemala, Nicaragua, Honduras	
Regional Watershed Management (Río Lempa Program)	Implement a Hydrologic Forecast System for the Río Lempa Watershed	Implement a Prototype Landslide Prediction Capability	1) Installation and implementation of the National Weather Service River Forecast System (NWSRFS) for the Río Lempa watershed (see Appendix for implementation description, workshops)
2) Install real-time precipitation gage network to support NWSRFS operations in the Río Lempa watershed - 2 new gages in Guatemala, 2 add-on gages at PAES streamgages in El Salvador, 2 upgraded precipitation stations (addition of telemetry) in Honduras	3) Design a regional hydrometeorological forecast center to support the requirements of the NWSRFS including installation of communications links to receive and disseminate field meteorological and hydrologic data, development and dissemination via Internet, fax and voice of NWSRFS forecast products for different users, and installation of a Local Area Network within the forecast center.	4) Develop indexed flood inundation maps for the lower Río Lempa using the NWSRFS models, develop concept of operations to use the maps during flooding events	5) Design and implementation of a landslide prediction capability to supplement the river and flood forecasting capabilities.
El Salvador	El Salvador, Guatemala, Honduras	El Salvador	
Lower Río Lempa	Río Lempa watershed		

#### A) Regional Center in Support of Hydrometeorological Activities in Central America

The NWS will work with CRRH in exploring the development of regional center in support of hydrometeorological activities in Central America. Much as the NOAA's National Hurricane Center serves the United States and the Caribbean Basin, a Center for Disaster Reduction could serve as a focal point for regional forecasting and warning and provide a coordinated approach to managing weather-related natural disasters.

Although the DoC Implementation Plan (July 1999) discussed myriad of activities for the Center, it is anticipated that a strong focus will be regional efforts for sustaining hydrometeorological monitoring and early warning technology being provided both by country and regionally in Central America. This would include technology applications and data gathering, system maintenance, and hydrometeorological data quality control. The evaluation for the Center would be accomplished in concert with national strategic plans being developed which also address these issues but on a country-by-country basis. Additional concepts for a regional center would include a focal point for future professional development and training, and provide the means for concerted efforts in requesting technical cooperation in areas such as vulnerability studies, technology transfer and regional modeling.

In consultation with the affected countries and other regional organizations, such as CCAD and CEPREDENAC, NWS and CRRH will develop the framework and a proposal for the Center, including logistics (e.g., telecommunications networks, staffing), location, and funding requirements.

### National Weather Service River Forecast System Implementation

The implementation of the National Weather Service River Forecast System (NWSRFS) will occur beginning in early calendar year 2000 through completion of the program on December 31, 2001. Because of the complexity of the implementation, the entire implementation process is described in this Project Plan, even though some tasks will be accomplished during the second phase of the program.

See Appendix for a description of the NWSRFS implementation, including training programs.

### Prototype Landslide Prediction Capability

A prediction capability to provide early warnings for landslides will be designed during the first phase of the regional program and will be installed and implemented during the second phase. This pilot program is based on a simplified approach using a relationship between precipitation duration and intensity and landslide probability. This relationship is based on studies in Puerto Rico. Puerto Rico is impacted by precipitation events similar to those in Central America and has similar terrain. A PC-based computer program will be developed and installed in the Río Lempa forecast center and will use real-time precipitation data. This activity will be coordinated with precipitation gage installations needed to support the NWSRFS. These efforts will also be coordinated with the U.S. Geological Survey to determine study areas vulnerable to landslides.

### Indexed Flood Inundation Maps

A series of indexed flood inundation maps will be produced using the dynamic hydrologic models in the NWSRFS. The maps will be indexed to various releases from the 15 de septiembre dam (furthest downstream dam) and to the current sea level (tide) based on a gage to be installed by NOAA/NOS near the community of La Pita on the lower Río Lempa. The maps will be provided to SMHN, CEL (operators of the dam), and potentially affected communities. Use of the maps will show potential areas of flooding for combinations of dam releases and sea levels. Coordination between CEL, the community and SMHN will help mitigate the impacts of large releases of water from the 15 de septiembre dam. Real-time sea level data will be provided to CEL, the community and SMHN to aid in the flood potential evaluation. As part of this activity, detailed training will be provided to all users.

A)

#### Training

Training programs specific to the Río Lempa NWSRFS activity are discussed in the Appendix.

The training planned in support of the Central America Regional Program will include workshops on the NWSRFS and on hydrologic forecasting. The NWSRFS is a one week workshop held in the United States focused on the application of the NWS hydrologic forecasting system. A second workshop, also in the United States is co-sponsored by NWS and the World Meteorological Organization. This is a one month workshop on hydrologic forecasting in general. These workshops are complements to other training programs being accomplished through the country programs. Counterpart agency representatives from the four Mitch-affected countries will be sponsored through the regional program.

Workshops will have Spanish translation services provided.

#### B. Coordination of Activities

The NWS activities will be performed in coordination with activities by USAID, other USG agencies, and other donors. This will be done to eliminate overlap and redundancy as much as possible. Table 3 summarizes the activities to be coordinated in the region.

As indicated in the table, the NWS activities in the region must complement the activities planned for the country programs, especially in El Salvador where the largest portion of the Río Lempa watershed lies. The design of all programs will need to ensure that there is a seamless interface between them.

<b>Table 3. Agency Coordination</b>	
<b>Organization</b>	<b>Activities to be Coordinated</b>
NOAA - National Ocean Service	Installation of meteorological sensors on tide gages and at
Continuously Operating Reference Sites (for GPS), where applicable	
NOAA - National Environmental, Satellite, Data, and Information Service	Implementation of
one kilometer resolution satellite imagery capability - coordination of imagery processing hardware and software and precipitation estimates within counterpart agencies. Precipitation data will be used in the National Weather Service River Forecast System (NWSRFS) for the Río Lempa watershed.	
NOAA - Office of Global Programs	Implementation of climate forecasting capability within
counterpart agencies. These data will be used in the NWSRFS for the Río Lempa watershed.	
U. S. Geological Survey	Installation of streamflow gages - coordinate data needs for
support to the NWSRFS and co-located meteorological measurement instrumentation; coordinate INTERNET needs and capability requirements for NWSRFS output dissemination; determination of landslide vulnerable areas.	
Federal Emergency Management Agency	Coordination on the development of emergency plans to
support implementation of the NWSRFS and coordination with emergency operations center NWSRFS product requirements	
USAID - Bilateral Central America Missions	Coordination of related in-country flood early
warning (ALERT), hydrometeorological monitoring, flood and river forecasting (NWSRFS), and capacity building programs	
USAID - GCAP	Coordination on the development of a Río Lempa watershed
management plan including the implementation of a river and flood forecast system for the Río Lempa, installation of streamflow gages (in coordination with the U.S. Geological Survey), densification of the precipitation monitoring network, and integration of flood early warning systems, coordination of all program activities with SICA and corresponding counterpart regional agencies.	
USAID - OFDA	Coordination with the disaster preparedness assessment and
recommended actions, as applicable	
Atmospheric Environment - Canada	Coordination with base infrastructure reconstruction and flood
early warning system activities to include hardware installation and maintenance	
World Bank	Coordination on program expansion, maintenance and
sustainability issues	
Inter-American Development Bank	Coordination on program expansion, maintenance and
sustainability issues	
World Meteorological Organization	Coordination on long term program planning

### C. Applicability to Other Plans

The NWS regional program is consistent with the needs and requirements outlined in the following, applicable plans and/or reports.

- U.S. Department of Commerce's Implementation Plan for Reconstruction Work in Central America, U.S. Department of Commerce, July 1999
- Project Plan For Reconstruction Work in Central America, Regional Program, Phase I, November 1999



- Project Proposals, Natural Disaster Prevention Support and Water Resources Management, Modernization of National Meteorological and Hydrological Services Affected by Hurricane Mitch - El Salvador, Guatemala, and Honduras, World Meteorological Organization, June 1999
- Special Objective Document, Improved Regional Capacity to Mitigate Transnational Effects of Disasters, USAID/G-CAP
- Country Project Plans, NOAA, Phase I and Phase II, August 2000

#### IV. MANAGEMENT PLAN

##### A. NWS Management Structure and Responsibilities

The NWS will provide a management structure to ensure the Regional program meets all USAID requirements and commitments. The NWS managers directly responsible for this project include the NWS Project Manager and the Regional Manager. Their responsibilities are as follows.

##### NWS Project Manager

- Develop and track project schedules and budgets
- Develop overall technical approach and tasks for each country and the region
- Develop country and regional work plans including a detailed cost plan
- Attend program meetings as required by NOAA management and USAID
- Coordinate local and in-country technical advisors, as appropriate
- Work with the NOAA Program Manager to coordinate activities and integrate tasks with other USG agencies
- Address line office, NOAA/DoC and USAID administrative requirements, including reporting requirements
- Provide input to the NOAA Program Manager for the NOAA quarterly progress report due to USAID
- Coordinate Country and Regional Managers and activities, as appropriate
- Coordinate activities with other NOAA line offices
- Develop contractor Statements of Work and Coordination of contractor activities with the NOAA Program Administrator
- Coordinate activities (including country clearances) with the NOAA Program Manager, USAID in-country missions and USAID/Washington program coordinators, as appropriate
- Coordinate with the NOAA Program Manager and the Regional Country Manager for additional, future donor support for appropriate project tasks

##### Regional Manager

- Coordinate all technical tasks
- Track regional schedules and budgets
- Coordinate all regional activities with the line office project manager, USAID/G-CAP, counterpart regional and country agencies, other USG agencies and any technical advisors and coordinators
- Assist the NWS project manager with the development of a project plan for NWS activities in the region and with administrative and reporting requirements
- Coordinate NOAA/NWS contractor activities in the region
- Coordinate shipping of equipment with USAID/G-CAP and/or the appropriate USAID bilateral mission
- Address personnel safety and security issues with in-field personnel (contractor and government personnel) and the appropriate bilateral USAID mission
- Coordinate activities and requirements with any Private Volunteer Organizations and Non-Governmental Organizations (NGOs), e.g. coordination with disaster preparedness/management plans
- Work with other donors, including USAID, to expand and extend the implemented programs

##### B. NWS Contact Information

NWS Project Manager -

Mr. Robert Jubach  
U.S. National Weather Service  
National Oceanic and Atmospheric Administration  
1325 East-West Highway  
Silver Spring, Maryland 20910  
301-713-0130 x 124  
301-713-1051 (fax)  
[robert.jubach@noaa.gov](mailto:robert.jubach@noaa.gov)

NWS Regional Manager -

Mr. Robert Jubach  
U.S. National Weather Service  
National Oceanic and Atmospheric Administration  
1325 East-West Highway  
Silver Spring, Maryland 20910  
301-713-0130 x 124  
301-713-1051 (fax)  
[robert.jubach@noaa.gov](mailto:robert.jubach@noaa.gov)

#### C. USAID Mission Assistance

It is understood that the USAID Missions (bilateral and G-CAP) will be the focal point for all NWS activities in the region. This includes acting as the liaison between NWS, its contractors and the appropriate regional and country counterpart agencies. Accordingly, the USAID Missions will need to assist the NWS Regional Manager with the following, at a minimum.

- All activities (in-country and regional) involving the NWS and its contractors including organizing meetings with and support from counterpart agencies, PVOs and NGOs and arranging for translators, if needed
- Country clearances for the NWS and its contractors
- Shipping and storage of equipment in the appropriate country
- Obtaining office work space, as needed

#### D. Measures of Progress

Measures of Progress and Measures of Effectiveness for each of the Problem Areas and activities have been defined in the DoC *Implementation Plan for Reconstruction Work in Central America*. The Measures of Progress are all activity outputs based on successful implementation of the defined activity. The DoC Quarterly Reports will also track progress for the various activities.

#### E. Program Sustainability

The NWS will work with the USAID G-CAP and bilateral Missions, regional and country counterpart agencies and other donors to develop a long-term strategy for expanding and sustaining the programs implemented. The NWS will also hold discussions with donors and regional agencies to determine best approaches to sustain these programs. A separate activity to look at regionalization of certain hardware and software maintenance needs and requirements is provided for in the DoC regional program.

#### F. Equipment Turnover

After successful installation and checkout, all hardware will be officially turned over to the agency(s) identified as responsible for maintaining the hardware and software associated with the regional program. This will be accomplished per USAID Mission requirements. Once the equipment becomes the property of the appropriate agency(s), all maintenance responsibilities will need to be assumed by that agency(s).

## V. SCHEDULE AND BUDGET

Although this plan focuses on activities to take place subsequent to the execution of the IAA between DoC and USAID, the NWS did perform some preliminary activities in order to be prepared to begin the program defined in the July 1999 DoC implementation plan. These preliminary activities included trips to Central America to meet with the USAID missions and with the counterpart country and regional agencies to begin the planning process. Some visits included field trips to areas where programs will be implemented. Constant dialogue was maintained with the USAID missions and, to some degree, with the counterpart agencies, as these project plans were being developed.

### A. Schedule

An implementation schedule for the entire program for key activities is provided in the following table.

<b>Table 4. Program Schedule</b>	
<b>Installation, Operational or Implementation Date</b>	<b>Activity</b>
By 30 September 2000	Regional Center concept description (NWS and CRRH) Workshop on flood forecasting with the NWSRFS Río Lempa NWSRFS technical overview workshop Río Lempa NWSRFS user requirements workshop Design of Río Lempa NWSRFS including monitoring network design (streamgages and precipitation gages) for NWSRFS support Purchase of Río Lempa NWSRFS and forecast center hardware and software
By 31 December 2000	By 31 December 2000
	Support a regional workshop on maintenance procedures, planning and regionalization approaches Collection of data needed to support the Río Lempa NWSRFS model calibration Installation of precipitation gage network to support the Río Lempa NWSRFS Río Lempa Forecast Center design (communications systems, data flow, networks) Installation of Río Lempa Forecast Center communications hardware and software Workshop on hydrologic forecasting co-sponsored by NOAA
By 31 March 2001	Implementation of a landslide prediction capability
	Completion of regional center framework
By 30 June 2001	Implementation of the preliminary Río Lempa NWSRFS - this is a complete, operational system making viable forecasts, system calibrations (i.e., fine tuning) and operational training continue Implementation of indexed flood inundation maps for the lower Río Lempa Completion of forecast center operations workshops
By 31 December 2001	All Río Lempa NWSRFS calibrations and training completed All Río Lempa NWSRFS training and system support completed All Río Lempa NWSRFS systems operational

### B. Budget

The NWS budget for the first and second phases of the regional program follows the budget outlined in the Interagency Agreement (IAA) between the Department of Commerce and USAID. Detailed activity budgets will be developed in conjunction with selected contractors to ensure adherence to the IAA tranced budgets. The budget breakdown is shown in Table 5.

<b>Table 5. Program Budget</b>				
<b>Problem Area</b>	<b>Activities</b>	<b>Description</b>	<b>Problem Area Budget through</b>	
<b>30 September 2000</b>	<b>Problem Area Budget</b>	<b>1 October 2000 - 31 December 2001</b>	<b>Total</b>	
<b>Problem Area Budget</b>				

Disaster Preparedness and Response (Central America Regional Program)	Develop a framework for a regional center in support of hydrometeorological activities in Central America	
Strengthen Forecasting, Warning, Preparedness, and Response Institutions	Provide regional center framework	
Workshop on flood forecasting with the NWSRFS	Workshop on hydrologic forecasting (NOAA/WMO)	
Support regional workshop on equipment maintenance	Series of workshops on forecast center operations	
\$100,000	\$105,000	\$205,000

Regional Watershed Management (Río Lempa Program)	Regional Watershed	
Management (Río Lempa Program)	Implement a Hydrologic Forecast System for the Río Lempa Watershed	
Río Lempa technical overview workshop	Río Lempa user requirements workshop	
Design of Río Lempa NWSRFS including monitoring network design	Purchase and installation of Río Lempa NWSRFS and forecast center hardware and software (including data communication systems)	
Collection of data needed to support Río Lempa NWSRFS model calibration	Río Lempa forecast center design	
Installation of precipitation gage network to support the Río Lempa NWSRFS	Implementation of the Río Lempa NWSRFS	
Implementation of a landslide prediction capability	Implementation of indexed flood inundation maps for the lower Río Lempa	\$1,100,000
All available funding was placed in the first tranche		\$1,100,000

## Appendix

# NWSRFS Implementation Río Lempa Watershed

## A. Overview

This activity will center on the design and implementation of the NWSRFS. This system will be part of the cross-border management plan developed for the Río Lempa watershed. The system will be a key element for flood and river flow forecasting and integrated water resources management throughout the watershed. The NWSRFS will provide information and data needed for cross-border river forecasting and for early warning of floods along the river.

The NWSRFS software modules provide real-time hydrologic modeling for forecasting, including potential capabilities for reservoir management and long-range (e.g., monthly, seasonal) probabilistic hydrologic forecasting. This regional forecast capability would provide input to environmental disaster mitigation efforts for water-related events such as floods and droughts as well as support integrated water resources management (e.g., important to agriculture, industry, hydroelectric power - which represent potential water conflicts) throughout the watershed. Daily river forecasts will be provided to the appropriate agencies and private sector users in each country in the watershed. During periods of flooding, more frequent forecasts will be issued. To ensure proper operation of the NWSRFS, information and data on the operation of dams in the watershed will need to be made available into the system.

To support the NWSRFS input data requirements, the NWS will also supplement existing precipitation gage networks in the watershed as well as install additional instrumentation at selected locations for mudslide forecasting. The NWS will collaborate with the U.S. Geological Survey on the installation of streamflow gages throughout the watershed. The NWS will provide training and support on implementation and operation of the NWSRFS and will ensure that data and information is accessible to all required entities.

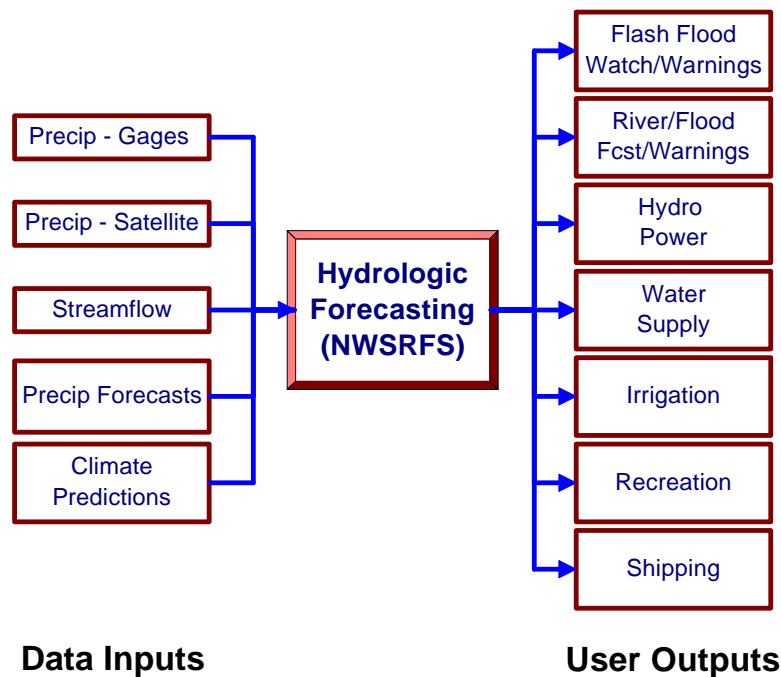
## B. Implementation Tasks

## 1. System Design

The NWS and its contractors will work with USAID/G-CAP and the counterpart Central America regional and country agencies to develop the design of the NWSRFS. The design process will include the following activities:

- **Definition of the functional requirements** - depends on amount, type, representativeness, availability and reliability of the input hydrometeorological data; the data communication interfaces; the capabilities and experience of the eventual operators; operator requirements; the hydrologic, hydraulic and meteorological characteristics of the basin and the required outputs (e.g., user requirements). Based on these factors, the software functional requirements, hardware requirements and data communications requirements can be defined and factored into the design of the system.
- **Definition of the Río Lempa Forecast Center** - including location, country responsibilities, staffing requirements, and integration with country forecast centers
- **Definition of outputs** - including determining users and user requirements (organize and implement a users workshop)
- **Definition of precipitation and streamgauge monitoring requirements and maintenance responsibilities**

The overall system design will consider the following requirements.



It is planned to include satellite precipitation estimates and climate forecasting outputs into the operational NWSRFS.

## 2. Computer Equipment Procurement

This task will be used to define and then procure the scientific workstations, personal

computers, software and other, peripheral technology needed to support the development and implementation of the NWSRFS, river forecast center operations and training of country personnel.

The NWS will develop specifications for the hardware and software needed for the project for NWSRFS development, training and operations. The NWSRFS has been developed to operate on Hewlett-Packard scientific workstations. The number of workstations needed (a minimum of two workstations is required to support development and training efforts) and the need for additional computer resources will be defined through this task. Initially, the workstations will reside at the NWS contractor facility and will be shipped to Central America for system installation at the conclusion of the project. The NWS will also investigate the need for additional equipment such as personal computers. Items such as personal computers will be procured as late in the project as possible in order to provide state-of-the-art equipment.

### 3. Data Inventory

This task will be used to collect the AVAILABLE hydrometeorological and supporting data needed to design networks, calibrate and implement the NWSRFS and its models.

Various hydrometeorological data and related information are needed from Honduras, Guatemala, and El Salvador in order to implement the NWSRFS for the Río Lempa watershed. Of special interest are those data that support estimating the water balance of the sub-basins draining to the Río Lempa. To accomplish this, historic precipitation, discharge, and evapotranspiration data are needed, where available. In addition, information regarding dams and reservoirs are needed as well as cross-section data and information for the lower Río Lempa - the reach where hydrodynamic modeling may be required because of the low river flow gradient (this will be determined during the design phase. The NWS will specify the data requirements, including preferred formats. As part of this task, the NWS will visit the various organizations in the three countries to assist with the data collection, review data collection practices. If data are available but not yet digitized, the NWS will develop a plan to digitize the needed data. Adjustments will be made on data requirements following the formal data inventory evaluation.

The types of data needed include the following (the exact requirements will be defined once the project is implemented).

**Hydrometeorological Data** - In general, the following information is needed about the available hydrometeorological data:

- Data source;
- Data formats, and;
- Data networks (station identifiers, station locations, reporting intervals, observation times, period of record, overall data quality).

Precipitation - Historical precipitation data are needed for model calibration. Normally, a minimum of ten years is used for model calibration. These data must be for the same period of record as the historical streamflow data. A longer period of historical data is needed for the Ensemble Streamflow Prediction (ESP) capabilities in NWSRFS. Normally, a minimum of twenty years is used for ESP.

The preferred precipitation data include:



- Daily data. (Daily data are not needed if an adequate number of shorter time interval stations are available, however, daily data are often of higher quality.);
- 1-hour, 3-hour, or 6-hour data. (These data are needed to determine time distribution of precipitation.), and;
- Isohyetal maps that show seasonal/annual distribution of precipitation. This information is needed in order to infer the spatial distribution of precipitation in a basin. There may be significant orographic effects in the basin that may not be accounted for with a sparse precipitation network. If isohyetal maps are not available, any climate studies or orographic precipitation analyses which have been done would be used to provide information on regional precipitation vs. elevation relationships.

Potential Evapotranspiration - The soil moisture accounting model can use daily values or average monthly values of potential evapotranspiration. Potential evapotranspiration is usually estimated from potential evaporation values using an assumed vegetation demand. Potential evaporation can be estimated from pan evaporation data or it can be computed from meteorological parameters, i.e., air temperature, humidity, wind, and solar radiation, if these data are available.

Streamflow data - Historical streamflow data are needed for model calibration. The availability of these data will largely determine the basin subdivision for calibration. Historical streamflow data are needed for any point that is designated as a forecast point. Daily data are normally adequate for calibrating basins larger than a few hundred square miles, however, it is helpful to have some instantaneous data for estimation of basin unit hydrographs. Ideally, these data will have been processed and quality controlled, with changes in rating curves already accounted for.

Real-time streamflow data are needed as a basis for making adjustments to forecasts in real-time. These data are usually available as instantaneous stages and must be processed through a rating curve. Rating curves are needed for the operational forecast system. The NWS will work with the U.S. Geological Survey to develop a real-time streamflow gaging network.

Diversion data - Historical diversion data (e.g., irrigation) are needed so that these data can be accounted for in basin calibrations. Ideally, daily values would be available, but monthly or average monthly values can be used to construct a daily diversion time series. Real-time estimates of diversions are needed for operational forecasting.

Reservoir data - Historical time series of reservoir pool elevations and reservoir releases are usually used to estimate historical reservoir inflows. These data are used to calibrate the local area draining to the reservoir, but they are also needed to calibrate the reservoir model in the NWSRFS itself.

In addition, parametric information is needed for modeling reservoirs. These parametric data include:

- pool elevation vs. storage relationship;
- pool elevation vs. reservoir surface area relationship;
- spillway characteristics, i.e., rating curve information;
- reservoir operating objectives, and;
- reservoir operating plans, i.e., rule curves, regulation schedules, etc.

**Dynamic Routing Information** - Since dynamic routing may be required for channel reaches on the lower Río Lempa, channel cross-section information will be required. Topographic maps may be used to supplement cross-section data. Historical discharge and stage data along the reach will be needed to calibrate the dynamic routing model. If these data are not available then

the NWS will develop a plan to obtain the required data.

**Hydrologic Routing Information** - Cross-section information is useful but not required for other routing models that are included in NWSRFS. Historical streamflow data are usually sufficient for calibrating a hydrologic model.

**Spatial Data Sets** - Digital basin boundaries, river reaches, and political boundaries will be needed for map displays. In addition, data sets of elevation, soils, and land cover will be useful for calibration.

**Maps** - In the event that digital information is not available, maps with topography, basin boundaries, and station networks will be helpful.

**Reports** - Hydrometeorological reports may provide useful information. These reports may include water balance studies, precipitation studies, design reports, and reservoir operating manuals.

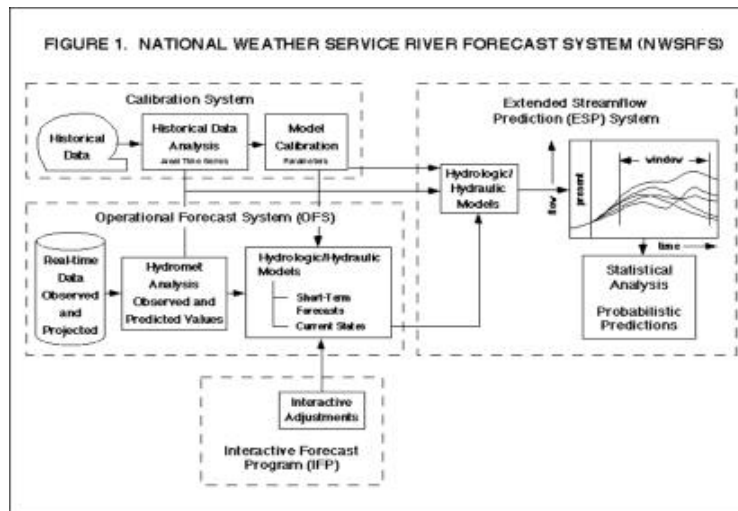
#### 4. NWSRFS Implementation

This task will be used to implement the NWSRFS for Río Lempa. Upon completion of this task, the NWSRFS will be completely operational for forecasting river flows.

The implementation of the NWSRFS involves many different sub-tasks to calibrate the models and initialize the system. The NWSRFS will be configured specifically to meet the requirements defined during system design. The system will be comprised of the following three primary components.

- Operational Forecast System - Real-time hydrologic modeling and forecast generation
- Calibration System - Parameter estimation and optimization
- Ensemble Streamflow Prediction - Long-range probabilistic hydrologic forecasting

The following figure provides a basic schematic of the NWSRFS and shows the relationships of the key systems.



Development and implementation of the NWSRFS will be a combined effort between the NWS and country engineers responsible for the operation and maintenance of the system. This cooperative development approach will provide the engineers with training specific to the system being installed. Much of the development work will occur in the United States with some follow-up training in Central America prior to system installation.

System implementation tasks (which begin after all necessary data and information have been collected) include the following.

- Hydrometeorological data pre-calibration analyses - this includes activities such as isohyetal map analysis, data consistency analysis, evaluate potential evapotranspiration estimates and perform water balance analyses;
- Sacramento Soil Moisture Accounting Model (SAC-SMA) calibration and unit hydrographs development - this includes activities such as development of mean areal precipitation estimates to be used in the calibration;
- Streamflow routing model calibration - this includes definition of parameters for the routing model selected for this portion of the basin;
- Ensemble Streamflow Prediction implementation - this includes analyses and development of the appropriate long-term historical precipitation time-series used to develop the ESP module;
- Operational Forecast System (OFS) and Interactive Forecast Program (IFP) implementation - this includes initialization of the OFS preprocessor and forecast components and incorporation of any precipitation estimate and forecast components;
- Data management interface development and implementation - this includes the development and implementation of a data management interface which formats input to and output from the NWSRFS, and;
- NWSRFS system integration and installation - this includes integration of all system components, preliminary system testing (prior to shipment), shipment of workstation(s) to Central America, support with the development of a data communications network for the exchange of data specified users, integration of the system/workstations with the data communications network, final system testing and issuance of User's Manuals (in Spanish).

## 5. NWSRFS-Specific Training

Intensive training is required in order to successfully operate the NWSRFS for the Río Lempa watershed. Training provides an opportunity for the NWS to discuss the technical capabilities of the NWSRFS in greater detail as well as discuss the specific system needs, capabilities and requirements. Training for this program will be accomplished in four modules: data analysis, model calibration, system implementation and daily operations. Training will take the form of workshops as discussed in this task and cooperative development exercises (as discussed earlier) as the NWSRFS is designed, developed and implemented. The training schedule is coordinated other technical tasks discussed in this plan.

**Technical Overview/Information Training** - This training will be oriented toward the operators and those persons technically responsible for the NWSRFS. The training will be a precursor to finalization of the system design. Training for this task will be in a workshop format and will focus on an overview of the fundamentals of the NWSRFS and its components, theory of the models and techniques and calibration and initialization of the system. During the workshop, data and information needs, data collection practices and data availability for the NWSRFS implementation will be discussed.

**User Requirements Training** - This training will be oriented toward the users (public and private) of the outputs from the NWSRFS. Training, in the form of a workshop, will be given to those users identified by USAID/G-CAP and country and regional counterpart agencies. The workshop will have discussions of what types of data and information are available from the NWSRFS and how these data can be used. The participants will discuss their needs and user products for the NWSRFS can then be defined.

**UNIX Operating System Training** - This task will be used to provide training on the UNIX operating system for those Central American engineers and information technology personnel involved with the NWSRFS operations and scientific workstation system administration. A training program will be designed to provide UNIX operating system training for scientific workstation users and system administrators. The training is essential to the successful operation of the scientific workstations used for the NWSRFS. The types of courses to be considered are, for example, *Fundamentals of the UNIX System*, *System Administration Basics* and *Troubleshooting*.